

CLAIMS

What is claimed is:

- 5        1. An agricultural inoculum suitable for inoculating plant seeds, said inoculum comprising:  
                a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3  
                (ATCC 58678) and mutants thereof;  
                a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens*  
                TJ1000 or 1BE (ATCC BAA-390) and mutants thereof; and  
                a suitable carrier that is non-phytotoxic, non-bacteriostatic, and non-bacteriocidal.
- 10        2. A composition of matter comprising:  
                a plant seed inoculated with a combination comprising a fungal antagonist selected from  
                the group consisting of *Trichoderma virens* GL-3 (ATCC 58678) and mutants thereof and a  
                bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or  
                1BE (ATCC BAA-390) and mutants thereof;  
                wherein said combination suppresses growth of plant pathogenic fungi.
- 15        3. A plant inoculated with a combination comprising:  
                a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3  
                (ATCC 58678) and mutants thereof; and  
                a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens*  
                TJ1000 or 1BE (ATCC BAA-390) and mutants thereof;

wherein the combination suppresses growth of plant pathogenic fungi and the plant is selected from the group consisting of

5 corn,

sunflower,

soybean,

field pea, and

wheat.

10 4. A method of protecting a plant from disease caused by a plant pathogenic fungus comprising:

15 inoculating seeds from said plant with a combination comprising a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3 (ATCC 58678) and mutants thereof and a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) and mutants thereof;

20 wherein said combination suppresses growth of plant pathogenic fungi.

5. A method of protecting a seed or a plant from disease caused by a plant pathogenic fungus comprising:

inoculating seeds from said plant with a composition comprising a spore-forming fungal antagonist and a spore-forming bacterial antagonist.

20 6. The method of claim 5 wherein the spore-forming bacterial antagonist is selected from the group *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) and mutants thereof.

7. A method of protecting a seed or a plant from disease caused by a plant pathogenic fungus comprising:

inoculating seeds from said plant with a composition comprising a fungal antagonist and

5       a bacterial antagonist;

wherein said combination suppresses growth of plant pathogenic fungi.

8. The method of claim 7 wherein the combination suppresses growth of the plant pathogen fungi *Fusarium*, *Phythium*, *Phytophthora* and *Penicillium*.

9. A method of protecting a plant from disease caused by a plant pathogenic fungus comprising:

inoculating seeds from said plant with a composition comprising a fungal antagonist and  
a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or  
1BE (ATCC BAA-390) and mutants thereof;

wherein said combination suppresses growth of plant pathogenic fungi.

10. A method for biologically controlling or inhibiting stalk rot or root rot comprising:

coating seeds with an effective amount of a composition comprising *Trichoderma virens*  
GL-3 (ATCC 58678) and *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390).

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11. A process for making a composition comprising:

introducing an essentially pure culture of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) to a growth medium about eight hours after an essentially pure culture of *Trichoderma virens* GL-3 (ATCC 58678) is introduced to the growth medium; and growing the culture as a competitive culture.

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12. A process comprising making a composition comprising:

combining an essentially pure culture of *Trichoderma virens* GL-3 (ATCC 58678) with an essentially pure culture of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) in a 50:50 mixture; and applying said composition to a seed at a rate of at least 100,000 spores per seed.

13. A method for protecting plants in a growing medium from damping off and root rot fungal plant disease comprising:

placing in the growing medium in the immediate vicinity of the plant to be protected an effective quantity of the agricultural inoculum of claim 1.

14. A method for protecting plants from fungal plant disease comprising:

adding the composition of claim 2 in an effective quantity to a substrate selected from the group consisting of pelletized calcium sulfate or pelletized lime; and

20 placing the pellet in the immediate vicinity of the plant to be protected.

15. The method of claim 14 further comprising:

adding another plant growth nutrient to the pellet.

16. A method for protecting a plant from fungal plant disease comprising:

adding the agricultural inoculum of claim 1 in an effective quantity to a liquid solution;

and

5 applying the liquid solution in the immediate vicinity of the plant.

17. The method of claim 16 further comprising:

adding an additive to the liquid, said additive being at least one substance selected from  
the group consisting of

10 a plant nutrient,

a plant micro-nutrient, and

a chemical fungicide.

18. A method for biologically controlling a plant disease caused by a plant-colonizing fungus,

15 the method comprising:

inoculating a seed of the plant with an effective amount of a microbial inoculant  
comprising a combination of microorganisms having all of the identifying characteristics of  
*Trichoderma virens* GI-3 (ATCC 58678) and *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC  
BAA-390), said inoculation resulting in the control of said plant disease.

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19. The method of claim 18 wherein said inoculation results in the control of more than one  
plant disease.

20. A method comprising:

combining of a spore-forming fungal strain and a spore-forming bacterial strain to produce a product; whereby the combining step enhances ease of use and longevity of the product.

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21. A method comprising:

applying a *Trichoderma* spp. microorganism and a *Bacillus* spp. microorganism to a wettable powder to produce a combination; and  
applying the combination to a seed.

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22. A composition of matter made by combining:

a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3 (ATCC 58678) and mutants thereof;  
a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) and mutants thereof; and  
a suitable carrier that is non-phytotoxic, non-bacteriostatic, and non-bacteriocidal.

23. An antagonist for controlling plant pathogens made by combining effective amounts of:

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a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3 (ATCC 58678) and mutants thereof;  
a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) and mutants thereof; and  
a suitable carrier that is non-phytotoxic, non-bacteriostatic, and non-bacteriocidal.

24. An antagonist made by further combining with the antagonist of claim 23 an effective amount of another bacterial strain.

25. A seed assembly made by combining a plant seed with effective amounts of a spore-forming 5 bacterial antagonist and a spore-forming fungal antagonist.

26. The seed assembly of claim 25 wherein the seed is a seed of a plant selected from the group consisting of

a monocot, and

10 a dicot.

27. The seed assembly of claim 25 wherein the seed is a seed of a plant selected from the group consisting of

a legume plant, and

15 a non-legume plant.

28. The seed assembly of claim 25 wherein the seed is a seed of a plant selected from the group consisting of

20 corn,

sunflower,

soybean,

field pea, and

wheat.

29. A method for culturing a plant comprising:

applying the antagonist of claim 23 to a seed or to the seedbed of the plant;

planting the seed in the seedbed;

5 growing the plant to yield a crop; and

harvesting the crop;

wherein said applying step increases the yield of the crop.

10 30. The method of claim 29 wherein the antagonist is applied to the seed or to the seedbed of a plant selected from the group consisting of

a monocot, and

a dicot.

15 31. The method of claim 29 wherein the antagonist is applied to the seed or to the seedbed of a plant selected from the group consisting of

a legume plant, and

a non-legume plant.

32. The method of claim 29 wherein the antagonist is applied to the seed or to the seedbed of a  
20 plant selected from the group consisting of

corn,

sunflower,

soybean,

field pea, and

wheat.

33. A process comprising:

5 making a composition by combining an essentially pure culture of *Trichoderma virens* GL-3 (ATCC 58678) with an essentially pure culture of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) in a mixture; and

10 applying said composition to a seed; wherein said mixture ranges in composition from 10 to 90 percent *Trichoderma virens* GL-3 (ATCC 58678) by culture volume and from 90 to 10 percent *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) by culture volume.

15 34. A process comprising:

making a composition by combining an essentially pure culture of *Trichoderma virens* GL-3 (ATCC 58678) with a plurality of essentially pure cultures of bacteria in a mixture; and  
applying said composition to a seed; wherein said mixture ranges in composition from 10 to 90 percent *Trichoderma virens* GL-3 (ATCC 58678) by culture volume.

20 35. An antagonist for controlling plant pathogens made by combining effective amounts of:

a fungal antagonist selected from the group consisting of a strain of *Trichoderma virens* and mutants thereof;

25 a bacterial antagonist selected from the group consisting of *Bacillus amyloliquefaciens* TJ1000 or 1BE (ATCC BAA-390) and mutants thereof; and

a suitable carrier that is non-phytotoxic, non-bacteriostatic, and non-bacteriocidal.

36. The antagonist of claim 35 wherein the strain is *Trichoderma virens* Gl 21.

37. An antagonist for controlling plant pathogens made by combining effective amounts of:

a fungal antagonist selected from the group consisting of *Trichoderma virens* GL-3

5 (ATCC 58678) and mutants thereof;

a plurality of bacterial antagonists; and

a suitable carrier that is non-phytotoxic, non-bacteriostatic, and non-bacteriocidal.

38. The antagonist of claim 37 wherein the plurality of bacterial antagonists comprises a strain  
of *Erwinia carotovora*.

39. The antagonist of claim 37 wherein the plurality of bacterial antagonists comprises a strain  
of *Bacillus lentimorbus*.

DETAILED DESCRIPTION  
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